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POTATO CYST NEMATODES: GLOBODERA ROSTOCHIENSIS AND G. PALLIDA

N. Greco[1]

Globodera rostochiensis (Woll.) Behrens, and G. pallida (Stone) Behrens are the most pathogenic and widespread nematodes of potatoes. They are native species of the Andean mountains and have been spread all over the world with infected potato tubers. G. rostochiensis has been reported from Europe (where it was first found in Germany in 1923) and also in North Africa, North, Central and South America, the Mediterranean area, India, Japan, New Zealand and the USSR. In the USA, G. rostochiensis has been found only in New York State. G. pallida occurs in Europe (where it was detected first in England in 1973) and also in South America, Algeria, Canada, India, and New Zealand. G. pallida has not been reported in the United States.

Morphological characteristics: G. rostochiensis and G. pallida are very similar in their morphology and both form round cysts. The following characters are helpful to distinguish the two species. G. rostochiensis adult females turn yellow before becoming cysts and, therefore, the nematode is also known as the golden nematode (Fig. 1). No yellow phase is present in G. pallida. Twenty-two cuticular ridges are present between the vulval and anal apertures of G. rostochiensis cysts, while only 12 are present in G. pallida (Fig. 2A,B). Adult male and second stage juvenile (J2) bodies, adult female, male and J2 stylets and J2 tails are longer in G. pallida than in G. rostochiensis. Additional differential morphological characters are reported by Stone (9,10) and Mulvey and Golden (6).

Host Range: G. rostochiensis and G. pallida attack potato and several other Solanum species including eggplant and tomato.

Biology: G. rostochiensis and G. pallida are sedentary, endoparasitic nematodes. Their cysts can persist in the soil for more than 10 years. Root exudates produced by a host crop stimulate hatching of their eggs, which are enclosed in the cysts. Emerged J2 migrate toward a root tip which they penetrate. Once a feeding site is established, the J2 become sedentary and undergo three molts giving rise to third and fourth stage juveniles and finally adults. As juveniles molt and become swollen, they rupture the root cortex. Adult males are migratory and worm-like. Fecund white adult females produce a variable number of eggs (200-600) which are retained in their bodies. At the end of the reproductive phase, the adult females die and their cuticle becomes brown and thick, attaining the cyst stage. The cuticle of G. rostochiensis adult females turns yellow before the cyst stage is attained, in contrast to G. pallida adult females which maintain their whitish color before becoming cysts.

Newly produced eggs do not usually hatch until the next growing season. However, new egg hatching and the occurrence of an incomplete or complete second generation of the nematode has been observed under field conditions in southern Europe (7, Greco et al., unpublished). Both nematode species reproduce well at 20 C, but G. pallida seems better adapted to lower temperatures than G. rostochiensis.

Symptoms and Damage: G. rostochiensis and G. pallida induce the formation of specialized cells (syncytia) in infected roots. Syncytia are essential for nematode feeding and reproduction. Syncytia also cause vascular disorder and interruption of the flow of water and minerals from the roots to the leaves. Root function is impaired and infected plants become very sensitive to water stress.

Heavily infected plants senesce earlier and become yellow and stunted (Fig. 3A). Symptoms first appear in small patches (Fig. 3B) that enlarge year by year, especially when short term crop rotations are adopted.

The tolerance limit of potato to G. rostochiensis and G. pallida is in the range of 1.8-2.7 eggs/g of soil (2,8). At 8 and 64 eggs/g of soil, yield losses of about 20 and 70%, respectively, can be expected. Damage is less severe in areas where early crops are planted or where potatoes are planted in mid summer for harvest in November or December, as occurs in some Mediterranean countries. Under these conditions, nematodes do not complete their life cycle because of insufficient heat unit accumulation or because high summer soil temperatures delay egg hatch and, therefore, root invasion (7, Greco et al., unpublished).

Population Dynamics: Changes in soil population are greatly affected by environmental conditions and crop systems. Maximum reproductive rates of 58-128 fold have been observed in microplots (2). Population increase is greater on late potatoes than early potatoes. Late potatoes may allow a second complete or partial generation. Under fallow or non-host crop, the annual decline of the nematode population is in a range of 20-60%, and is higher in warm areas.

Control: Plant quarantine regulations in most countries require nematode free certification. Fumigant and nonvolatile nematicides are effective in controlling potato cyst nematodes (3,12), but there are restrictions on their use relating to the environment. Because of the narrow host range for potato cyst nematodes, crop rotation limits their damage and this agronomic practice should be encouraged. In general, a 3-5 year rotation is most effective. In countries where summer temperatures are

[1]Nematologist, Istituto Nematologia Agraria, C.N.R., 70126 Bari, Italy

Fig. 1. Potato roots infected with Globodera rostochiensis. Note yellow (golden) nematode adult females (arrows) which become brown cysts (C).

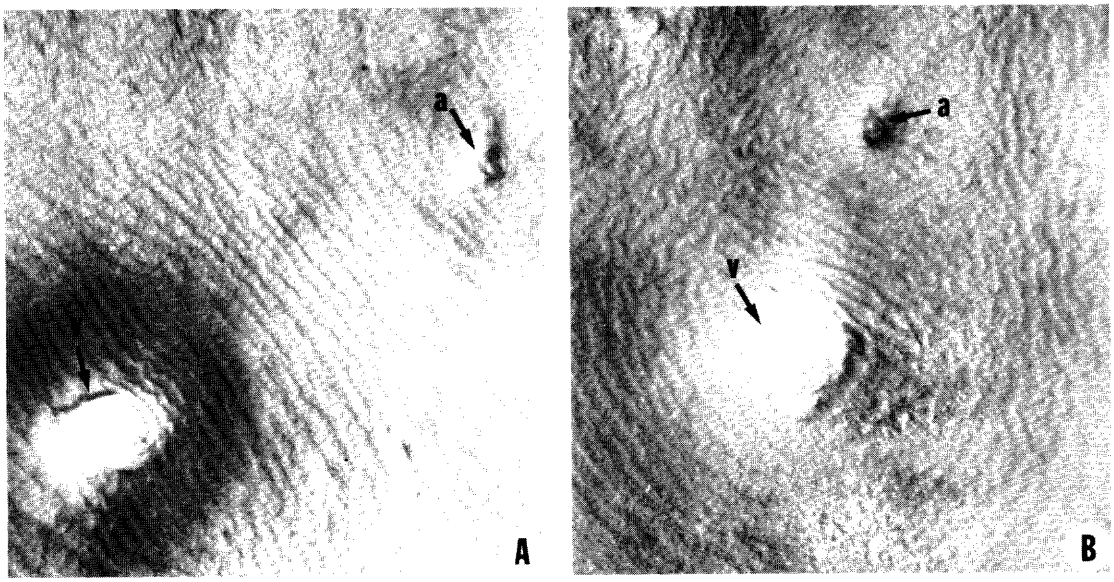

Fig. 2. Perineal patterns of A) Globodera rostochiensis and B) Globodera pallida. Note longer distance and more numerous cuticular ridges between vulva (v) and anus (a) in G. rostochiensis (A) as compared with G. pallida (B).

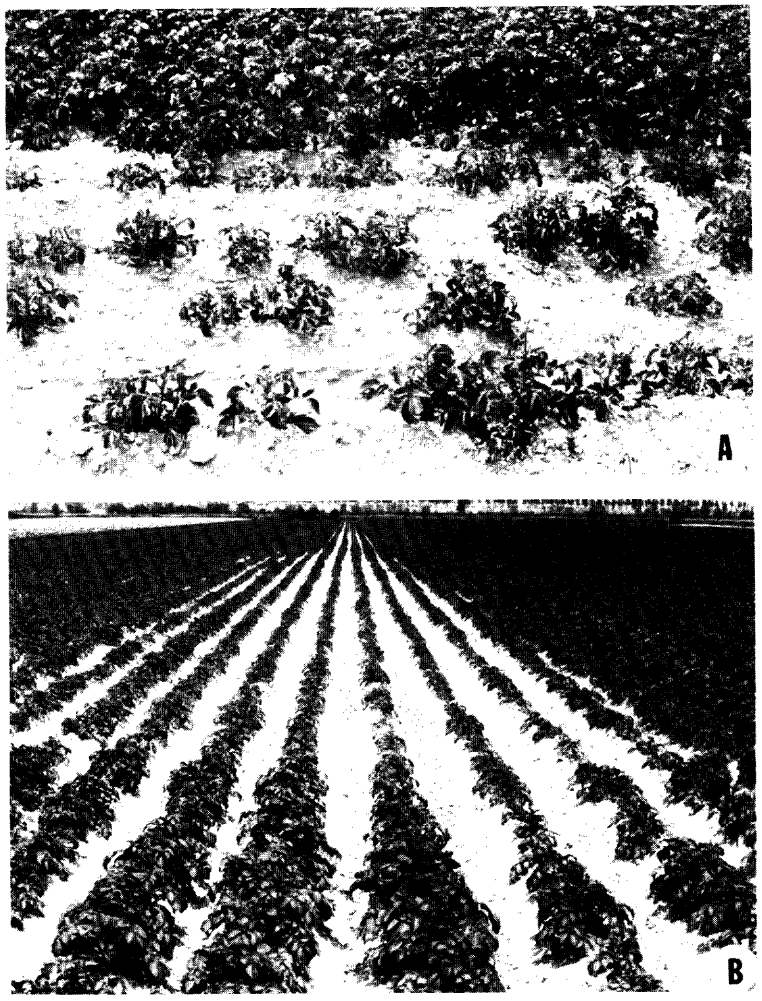

Fig. 3. A) Potato plants showing sparse growth and damage caused by Globodera rostochiensis attack; B) a large patch of small and stunted potato plants in a field infested with G. rostochiensis.

relatively high, a 4-8 week soil solarization would provide effective control (5). Early cropping would escape early nematode invasion. A number of resistant cultivars are available. Solanum tuberosum X S. tuberosum subsp. andigena is resistant to G. rostochiensis, and S. tuberosum X S. vernei is resistant to G. pallida. However, the use of resistant cultivars is complicated by the occurrence of several pathotypes. Five pathotypes of G. rostochiensis (Ro1, Ro2, Ro3, Ro4, Ro5), and three of G. pallida (Pa1, Pa2, Pa3) have been identified so far in Europe (4,11), but different pathotypes may also occur in Central and South America (1). In the US, only the pathotype Ro1 seems to occur. No potato cultivar is resistant to both nematodes nor to more than one pathotype of the same species. The pathotype present in a field must be known in order to choose the proper resistant cultivar. However, additional pathotypes may occur together in the same field which may become dominant under selection pressures exerted by the use of a previously resistant cultivar. Thus, nematode management should consider the alternate use of resistant cultivars, crop rotation, and chemical control of soil solarization.

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